

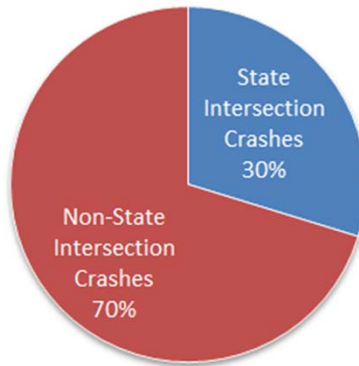
IMPROVING RURAL INTERSECTION SAFETY

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IN Intersection Statistics

- 93,250 Intersection-related crashes
- 24% Fatal and Injury crashes



2012 data

Nationally, intersections represent more than 20 percent of all fatalities and more than 80 percent of rural intersection fatalities occur at unsignalized intersections.

Intersection Crashes

Potentially severe

- Right Angle
- Left Turn
- Pedestrian

Typically less severe

- Rear End



Don't discount Roadway Departure crashes, they may be running off the road to avoid an intersection crash.

Intersection Crashes

- Note consistent patterns in crashes
 - ▣ Crash reports
 - ▣ Talk with law enforcement
 - ▣ Citizen complaints
 - ▣ Near misses
- Consider time of year and time of day
- Road Safety Audit

Look for patterns – may be one direction that is worse

Rural Intersection Behavior

Did the driver stop?

Driver does not stop

Intersection awareness

Sight distance

Driver expectancy

Driver stops then starts

Sight distance

Driver expectancy

Believes it's an all-way stop

Unsignalized

Making Intersections Safer

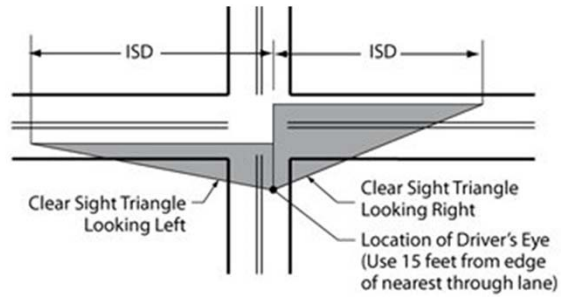
- Improve **sight distance** at intersections
- Increase **awareness** of intersections
- Increase **visibility** of intersections and traffic control devices
- Improve driver **comprehension** to reduce confusion
- Improve driver **compliance** with traffic control devices
- Improve the **operations** of intersections
- Improve **design** of intersections to reduce conflicts

First 5 are typically low-cost and easy to implement so we'll focus on those

Intersection Sight Distance

What affects intersection sight distance?

- Trees
- Vegetation
- Crops
- Utility poles
- Snow
- Signs
- Parked/turning vehicles
- Roadway Geometry



What blocks or affects sight distance?

Improve Sight Distance



Adequate sight distance for drivers at stop- or yield-controlled approaches to intersections has long been recognized as among the most important factors contributing to overall safety at unsignalized intersections.

- Sight distance improvements can often be achieved at relatively low cost by clearing sight triangles to restore sight distance obstructed by vegetation, roadside appurtenances, or other natural or artificial objects.
- The top photo shows how much the sight of the driver is restricted when they stop at the stop bar.
- The bottom photo shows how far a driver needed to pull in front of the stop bar to see adequately.
- The photo on the right shows a more urban solution of restricting parking by striping near an unsignalized intersection in order to improve the sight distance.

Improve Awareness of Intersection



The visibility of intersections and, thus, the ability of approaching drivers to perceive them can be enhanced by installing larger regulatory and warning signs at intersections.

- Such improvements may include:
 - stop signs
 - intersection warning signs
 - stop ahead signs
 - pavement markings
 - post-mounted delineators
- The FHWA *Older Driver Highway Design Handbook* encourages such improvements to contribute to a better driving environment for older drivers.
- One limited study has indicated that **installing larger stop signs** may decrease all crashes by up to 19%.
- Another study concluded that **installing double stop signs** can reduce all crashes up to 11% and right-angle crashes up to 55%. The same study concluded that **installing advance warning signs** can reduce all crashes up to 30% at urban locations and 40% at rural locations.
- Yet another analysis indicated a crash reduction of 70% when **flashing beacons** were installed on advance of 3-leg intersections and up to 39% at 4-leg intersections.

Improve Awareness of Intersection



Also overhead flasher.

Splitter islands can be installed on minor road approaches to call attention to the presence of the intersection and to guide traffic through the intersection:

- A splitter island refers to a channelizing island that separates traffic in opposing directions of travel, as opposed to islands that separate merging or diverging traffic in the same direction of travel.
- Particularly appropriate on approaches to skewed intersections.
- Generally perceived to be effective in defining the presence of an intersection.
- When properly applied, they may reduce traffic speeds and intersection crashes, but there is no consensus on their effectiveness.

Overhead or sign-mounted flashing beacons can be used at stop-controlled intersections to supplement and call driver attention to stop signs:

- Intended to reinforce driver awareness of the stop sign and to help mitigate patterns of right-angle crashes related to stop sign violations.
- Florida estimated that overall crashes may be reduced up to 26% and injury crashes may be reduced up to 50% after installing flashing yellow-red signal indications.

Improve Awareness of Intersection



Providing lighting at the intersection itself, or both at the intersection and on its approaches, can make drivers aware of the presence of the intersection and reduce nighttime crashes.

- Minnesota conducted a literature review and found that previously published research reported 25 to 50% reductions in the nighttime crash/total crash ratio due to the installation of intersection lighting.

Rumble strips can be installed on intersection approaches to call attention to the presence of the intersection and to the traffic control in use at the intersection:

- Should be used sparingly.
- Their effectiveness is dependent on being unusual.
- Normally applied when less intrusive measures—such as pavement markings, “STOP AHEAD” signs, or flashers—have been tried and have failed to correct the crash pattern.
- One study concluded that transverse rumble strips may decrease overall crashes by up to 28% and rear-end crashes by up to 90%. Another study indicated that rumble strips installed in rural locations can decrease overall crashes up to 35%.

Increase visibility of intersections



Many stop signs at stop-controlled intersections are not readily visible to approaching drivers due to geometric conditions, presence of vegetation, or other objects (such as tall vehicles) that can limit the view of the regular stop signs.

- Intersection crashes may occur because approaching drivers may be unaware of the presence of the stop sign at the intersection.
- The visibility of stop signs and, thus, the ability of approaching drivers to perceive them, can be enhanced by providing supplementary stop signs suspended over the roadway.
- The safety effectiveness of providing supplementary stop signs mounted over the roadway has not been quantified.

Increase visibility of traffic control



Here's a good example at a local IN intersection that shows how to increase the visibility of the traffic control devices through the use of reflective strips on the sign posts. Note the proper location of the signs and the correct usage of the signs.



Use the right sign at the right size at the right location!

Increase Driver Comprehension



W4-4p



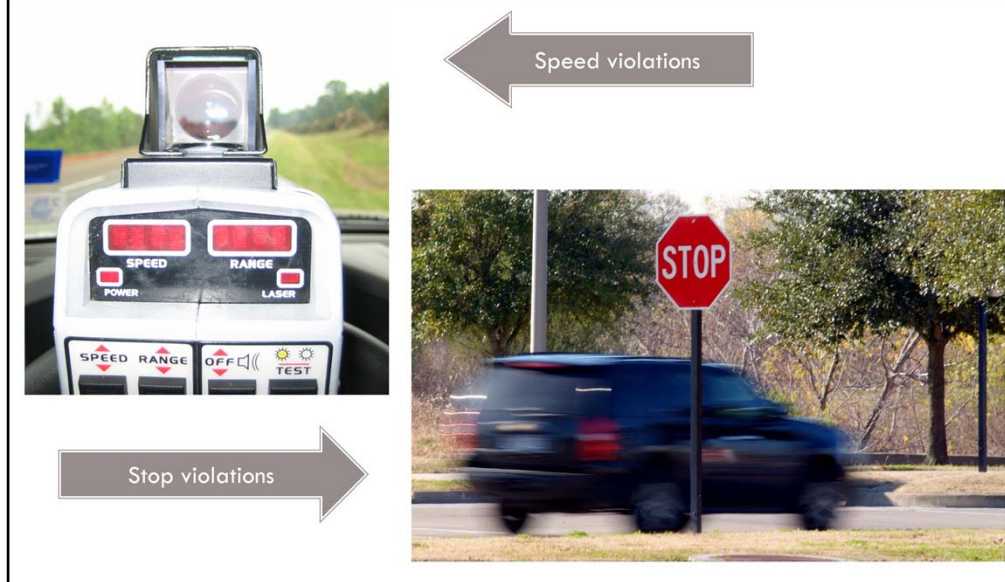
W4-4a



W4-4b

Reduce driver confusion

Increase driver compliance



Through targeted enforcement. Borrow our speed signs!

Enforcement options are a potential countermeasure to unsafe and illegal motorist behavior at intersections.

- Studies report the reduction of traffic law violations when enforcement is used.
- Traffic law enforcement agencies will often select locations for targeted enforcement when crash, citation, or other sources of information suggest that the site is unusually hazardous due to illegal driving practices.
- Programs within the United States have been found to result in decreases in violations of between 23 and 83%. However, the safety effectiveness of such decreases in violation rates has not been quantified.
- Enforcement agencies have generally found that the effectiveness of increased enforcement at specific locations has a relatively short duration of effectiveness—measured in days or weeks, rather than months or years.



Traditional low-cost infrastructure improvements may gradually lose their safety effectiveness as drivers who frequent the upgraded intersection may become less cautious and more inattentive over time.

Or some needed improvements may be cost-prohibitive.

Some intersections require additional, more active measures to improve safety.

Intelligent Transportation Systems (ITS)

- Computer and communication technologies
- Improve traffic conditions, minimize delays and increase safety
- Real-time situational awareness



Nationwide, intersection deployments using ITS have been successful in providing additional effectiveness. These systems offer drivers situational awareness in real-time and can target limited sight distance or poor driver decisions.

Intersection ITS

- Activated warning systems
 - Through vehicle
 - Approach vehicle
- Effective with limited sight distance
- **51-77% reduction in crashes (MO)**



Warning the through driver of too high an intersection entry speed and directing the driver to slow down.

Warning the through driver of another vehicle at a stop approach on a cross road.

Through vehicle and stop approach activated warning systems are applicable at isolated high-speed stop-controlled intersections with substantial sight distance limitations which either cannot be readily mitigated or are too costly to correct. Intersections that meet this criteria and have a history of crashes and near misses should be considered.

Through Vehicle Activated Warning Signs

- Warn through traffic a vehicle from cross street may enter the intersection
- Detectors on the stop approach identify approaching and stopped vehicles
- Activated flashing beacons on intersection warning signs
- Rural, stop-controlled intersections with crash history and limited sight distance

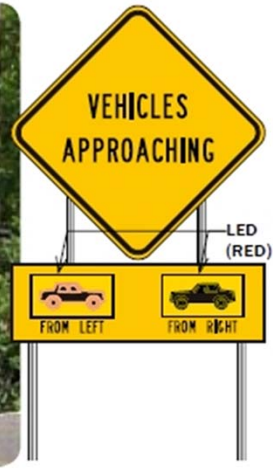
Through Vehicle Activated Warning Signs



Pennsylvania
Photo courtesy of PennDOT



Maine
Photo courtesy of MaineDOT



\$15,000-\$50,000



North Carolina
Photo courtesy of NCDOT



North Carolina
Photo courtesy of NCDOT



Minnesota
Photo courtesy of Mn/DOT



Virginia
Photo courtesy of VDOT



Missouri
Photo courtesy of MoDOT



Stop Approach Activated Warning Signs

- Speed detection system on stop approach
- Identify vehicles approaching a stop at an excessive approach speed
- Activate a flashing beacon on an advance “Stop Ahead” warning sign
- Cue lights on the perimeter of a stop sign to begin flashing

Stop Approach Activated Warning Signs



ITS Resources

Stop-Controlled Intersection Safety:
Through Route Activated Warning Systems



February 2011

U.S. Department of Transportation
Federal Highway Administration

FHWA-SA-11-015

Safe Roads for a Safer Future
Investment in infrastructure is the key to a safer future.



Using Low-Cost Technology to
Improve Safety on Local and Rural Roads



U.S. Department of Transportation
Federal Highway Administration

Systemic Improvements

- Traditional “hot spot” analysis
 - ▣ Based on crash rate/frequency
 - ▣ Can favor high volume roadways
- Systemic analysis
 - ▣ Based on high-risk roadway features that are correlated with particular crash types, rather than crash frequency.
- Best Approach: Combination of both!

Systemic Approach Elements

- Identify overall crash pattern
- Identify common high-risk characteristics
- Select countermeasures
- Implement across several locations

Potential Risk Factors

- High-risk intersection Features:
 - ▣ Geometric challenges
 - Skew angle
 - Horizontal curve
 - Vertical curve
 - ▣ Railroad crossing on minor approach
 - ▣ Commercial development in quadrants
 - ▣ Distance from previous stop sign
 - ▣ ADT ratio

Geometry of Intersection - Previous research has shown that skewed intersections have a higher risk of crashes. If an intersection has a skewed approach of greater than 15 degrees, it received a star.

Geometry of Roadway - Previous research has shown that intersections located on or near a horizontal curve are subject to a higher level of risk. Intersections located on or near horizontal curves received a star.

Commercial Development in Quadrants - Previous research has shown that intersections with commercial development located in one or more of the intersection quadrants have a higher level of risk. Private residences or farms were not included in this category. Intersections

with commercial development in a quadrant received a star.

Distance from Previous STOP Sign - Previous research has shown that drivers lose attention when traveling for longer distances without a STOP sign. Therefore, intersections with minor leg approaches without a STOP sign within 5 miles received a star.

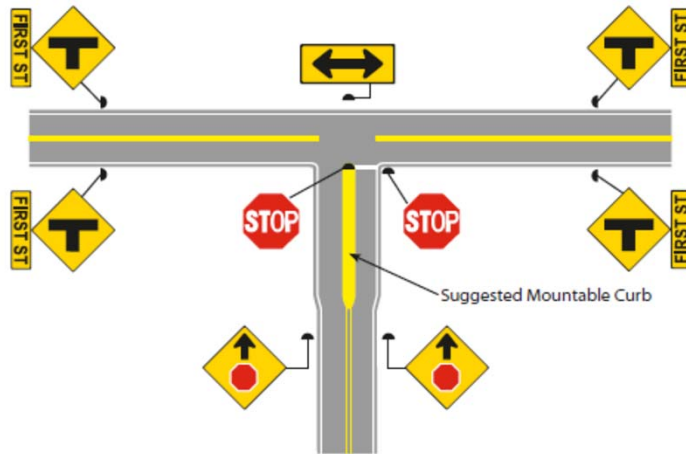
ADT Ratio - There is a range of ADT ratio (minor/major) on the County system that is more susceptible to severe crashes than others. Intersections with an ADT ratio between 0.4 and 0.8 received a star.

Railroad Crossing on Minor Approach - Intersections on or near a railroad line are subject to an increased level of risk. Drivers must navigate the railroad tracks while approaching the intersection. Therefore, if an intersection has a railroad crossing on one of the minor leg approaches to the intersection it received a star.

Crash History - If an intersection had experienced a crash during the five-year study period,

it received a star.

Systemic Treatment Package



Estimated Crash Reduction 30%

Basic set of signs and pavement markings.

Examples of Basic Low-Cost Countermeasures for Stop-Controlled Intersections:
Double Up Oversize Warning Signs, Double STOP Signs, Traffic Island on Stop Approach (if feasible), Street Name Signs, Stop Bars, and Double Warning Arrow at the Stem of T-Intersections

Questions?

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*The care of human life & happiness... is the first and
only objective of good government.*

- Thomas Jefferson